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THE RELATIONSHIP BETWEEN SIX SIGMA AND THE PERFORMANCE OF ROAD CONSTRUCTION PROJECTS IN RWANDA

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ABSTRACT

Improved project performance is the ultimate goal to all road project managers but achieving high performance in the construction industry is a challenge that road project managers face. The present research held on Goal Setting. Performance in project management is directly linked to customer satisfaction level. Client is only satisfied when projects meet the planned or expected quality. Thus, real performance is achieved when quality standards are met. In a study conducted in Rwanda, it was found out that there a significant relationship between six sigma and road construction project performance as tested using Pearson's correlation coefficient. The output given from the findings showed that that there was a significant positive relationship between the components of six sigma and components of project performance. Further the study concludes that six sigma is a key quality management technique and once taken into consideration during execution phase, it grants improved project performance of construction projects, roads in particular.

Keywords: Six sigma; Road construction; Project performance, Quality management techniques

INTRODUCTION

All over the world, every nation to sustain its development has to invest huge resources in construction of public infrastructures such as schools, hospitals, water supply, roads, sanitation, waste management, public buildings, bridges, etc.

In Africa, roads are the main mean of transport, for which the need is growing rapidly. It was noticed that most of the African countries do not do enough capacity to achieve the sustainability of road infrastructure as it has been widely reported that roads are affected to

varying degrees by premature deterioration. Many of the African countries have accepted institutional reforms, notably entailing the initiation of road funds and road agencies, and made significant progress on road maintenance. However, there are still challenges to be addressed in order to ensure appropriate maintenance. Though expenditures on road maintenance have increased over time in most African countries, it is still insufficient to cover the needs. Poorly maintained roads constrain mobility, significantly raise vehicle operating costs, increase accident rates and their associated human and property costs, and aggravate isolation, poverty, poor health, and illiteracy in rural communities (Hassan, 2018).

The performance of road and highway construction projects has been a subject to consider in East African countries particularly Uganda and many countries for quite some time. The problem of underperformance is not only affecting the road construction projects but also the construction industry. Studies show that construction projects and the industry at large have performed poorly in both the developed and under developed countries. (Christophe, 2017) asserts that shortage of skills of manpower, poor supervision and poor site management; unsuitable leadership; shortage and outdated equipment are among the factors that contribute to construction delays and subsequent performance problem. A research in South Africa (Jacob, 2003) reveals that conflict, poor workmanship and incompetence of contractors are among the factors affecting road project performance in most African countries.

Rwanda being a landlocked country where internal transportation method is mainly road transport, according to the Annual Report Fiscal Year 2017/2018, Rwanda's road network is classified into national roads (2,749km), District, City of Kigali roads and other urban roads. Class one (3,906km) according to the Ministerial Order No.01/ Cab.M/015 of 3rd March 2015, District roads class 2 (9,706km) and the unclassified roads totaling to about (21,145km). With the exception of national roads, other types of roads are considered feeder roads of which 78% are unpaved and need improvement.

Project performance management refers to the process of creating, implementing, and managing projects that gather to the performance of an organization and its strategy. Rather than focusing on task execution, project performance management is about the bigger picture (Jackson T. , 2020). A study conducted in Rwanda revealed that 47% of newly constructed roads get damaged before the expected time of first major maintenance due to failure to control quality during construction phase as one of the major cause of poor performance in road construction projects (Kayiranga, 2015).

In fact, the study conducted by Bert Markgraf (2018) revealed that the outcomes of implementing proper quality management techniques benefit not only government as a financing agency but also contractors in different ways like increased reputation, reduction of disputes and increased revenue from reduced operating expenses. Without a doubt therefore, road construction project performance is a recurring problem for many countries which negatively affect governments, contractors and business owners in achieving their goals.

According to records and based on researcher's firsthand experience with road performance in Rwanda, there are some road projects that suffer poor performance. For one, while checking road constructed in the last 10 years, three roads out of seven consulted has been damaged whereas road life span is expected to last 15 years before the first major maintenance (Jackson M. , 2015).

As a matter of fact, this fact is also observed in the report of RTDA. In their publication of fiscal year 2017/2018, RTDA (2018) found that some road underperform due to the use of inefficient technique in implementation combined with challenges associated this industry and implementing infrastructure megaprojects using classical approaches emerges challenges such as cost and time overruns, construction delays, abandonment, poor workmanship, contractor claims for additional payments among others.

Hence, it is precisely in this context that this paper aims to determine the relationship between six sigma as a quality management technique and performance of road construction projects in Rwanda.

Outcome of Goal setting theory of performance management system

In the late 1960s, Locke's pioneering research into goal setting and motivation gave the world a modern understanding of goal setting. In his 1968 article "Toward a Theory of Task Motivation and Incentives," he showed that clear goals and appropriate feedback motivate employees towards producing achieving the set goal. He continued on to highlight that working toward an objective is also a major source of motivation which, in turn, improves performance. Locke's research showed that the more difficult and specific a goal is, the harder people tend to work to achieve it.

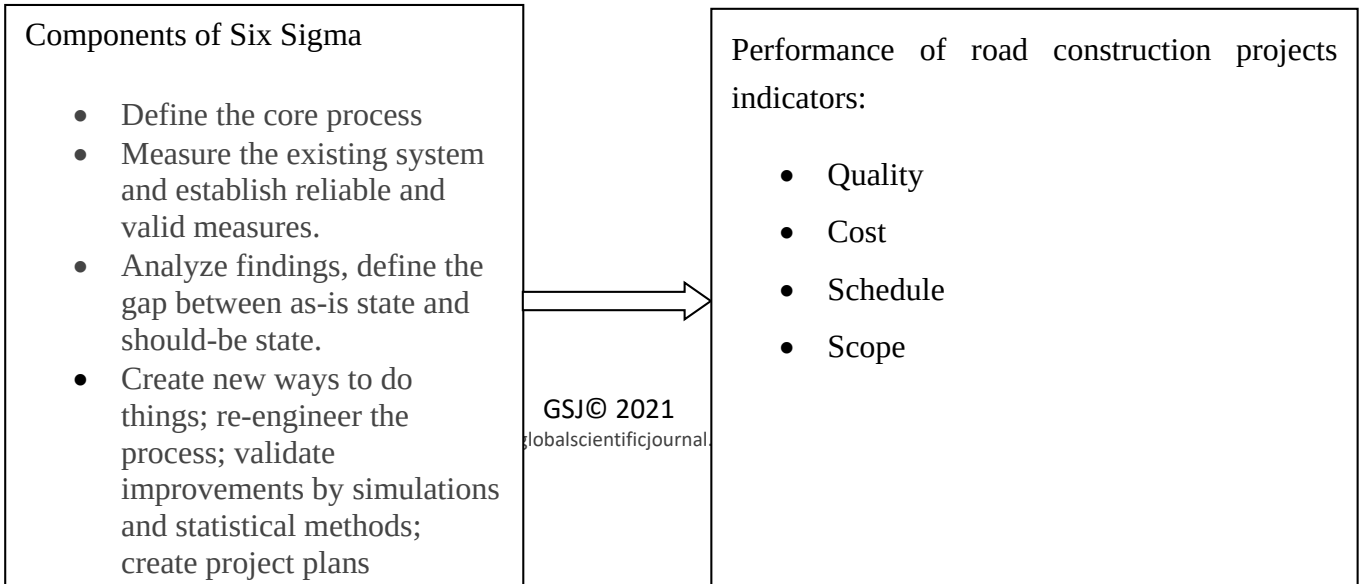
Goal setting theory had been proposed by Edwin Locke in the year 1968. This theory suggests that the individual goals established by an employee play an important role in motivating him for superior performance. This is because the employees keep following their

goals. If these goals are not achieved, they either improve their performance or modify the goals and make them more realistic. In case the performance improves it will result in achievement of the performance management system aims (Agarwal, 2011).

The pioneer of goal setting theory Edwin Locke states that if individuals or organizations set more tough goals, then they perform better. On the other hand, if the set goals are easy then the performance of an individual or organization decreases (Locke & Latham 2006). This theory by Locke was developed inductively after studying the psychology of organizations and industries over the years.

Goal setting theory in construction projects was adopted as a mean of achieving higher project performance and increasing customer satisfaction. A common complaint is that the client's brief is inadequate as a means for communicating the goals to the project participants. One of the primary purposes of project management, therefore, is to specify the clients' and participants' values and goals explicitly through a documentary process (Richardson, 2018). However, values and goals can be implicit and largely unspecified, quantitatively or qualitatively, or they may be quite explicit and detailed via the use of targets and quotas. A typical value management style postulates that the client's needs represent the assigned 'value specificity' in the decision process, while the project goal is considered to represent 'goal specificity' which is arrived from the participation of project members during the decision making process. Results from the research (Leung and Liu 2002) give a positive endorsement that goal specificity is influenced by primary value specificity and the client's requirements. Further, goal specificity and conflict resolution are associated with the final outcome (satisfaction) in construction projects. This shows that a higher degree of value–goal specificity and greater conflict resolution (integration) improve the final outcome (satisfaction) and influence the subsequent tasks.

Conceptual Framework



POPULATION AND SAMPLE SIZE

The target population is the entire population, or group, that a researcher is interested in researching and analyzing. For this study, the target population was selected to be professionals working or who have worked on road construction projects in public sector or private sector. A total of 170 respondents were selected. This is the total group of individuals from which the sample was also drawn. A sample is the group of people who take part in the investigation. The people who take part are referred to as "participants" (McLeod, 2019).

Sample size determination

For this research, the Slovin's formula sampling technique was used to allow a researcher to sample the population with a desired degree of accuracy. In this research, a sample was a small proportion of a population selected for observation and analysis. Slovin's formula is written as:

$n = \frac{N}{1+N(e)^2}$ Whereby, n: is the sample size, N: is the total population, e: is the margin of error,

Remember that for this case N= 170 members, taking the confidence level of 95% that is with a permissible error of 5%, e=0.05. Therefore,$n = \frac{N}{1+N(e)^2}$, $n = \frac{170}{1+170(0.05)^2} = \frac{170}{1+170(0.0025)}$

$=\frac{170}{1+0.4} = \frac{170}{1.4}=$ 122 respondents.

Table 3. 1: Sample size of the study characteristics

S/N	Major characteristics	Population	Sample size
1	Government officials	40	21
2	Consultant	23	45

3	Contractors	107	56
TOTAL		**170**	**122**

DATA ANALYSIS, FINDINGS AND INTERPRETATION

Response rate

The questionnaires were distributed to a total of 122 and out of them a total of 113 responded. This response rate was adequate according to Cooper and Schindler (2011) who note that a response rate of 80% and above is sufficient. Therefore, this response rate was sufficient to provide data for the study variables analysis and generalization. See table 3 of response rate.

Response rate		
Response rate	**Frequency**	**Percentage**
Response	113	92
Non response	9	8
Total	122	100

Validity Test Results

Validity refers to the degree to which an instrument accurately measures what it intends to measure. This research sought to avoid the bias of data collection and finding, which is essential to maintain research validity. Researcher isolated the research bias by avoiding pre-assumed beliefs and findings of the study.

Content validity was sought, Content Valid Index (CVI) is a scale developed by computing or ranking the relevant items in the instrument or questionnaire by checking their clarity, their meaningfulness in line with all objectives stated dividing by the total number of items (Neville, 2007). Content Validity is the degree to which an instrument has an appropriate sample of items for the construct being measured and is an important procedure in scale development. CVI is the most widely used index in the quantitative evaluation. Content validity ratio in this research was calculated using Lawshe (1975) formula:

$$CVR = \frac{n_e - \frac{N}{2}}{\frac{N}{2}}$$

"N" is the total number of experts doing the rating and "ne" is the number of experts rating the item as "essential". Any positive value indicates that over half of the experts rate the item essential. High CVR values would assure managers of the collection that a given resource has an agreed-upon potential value to surveyed end-users, while low CVR values would indicate a lack of agreement on its potential value (Schenck-Hamlin, 2011). The CVR obtained was greater than 0.5, implying that the instruments were valid. Computation gave out 0.8 which confirms the validity of instruments in this research as it greater than 0.5.

3. 6.2 Reliability of the Instruments

Reliability refers to the degree to which an instrument yields consistent results. Researcher achieved reliability by conducting the appropriate research method and design, where future researchers may replicate the study to confirm the conclusions. In this research, measure of reliability included internal consistency, test-retest, and inter-rater reliabilities as a type of answers the question, to determine whether the scores would be stable over time." Chronbatch's Alpha was used in this research and computation gave r = 0.70, giving evidence of consistency.

Relationship between six sigma and road construction project

The study sought to establish the relationship between six sigma and performance of road construction project in Rwanda. The majority of the respondents have highly agreed with large extent that incorporating six sigma has a strong relationship with road construction project performance. Respondents were given right to rate components of six sigma and how they are likely to influence the performance of the project. Based on the findings, six sigma influences road construction project performance and it corroborates with literature as stated (Shantanu Sathe, 2017).

Core process definition during project implementation and project performance

The respondent's views were sought on whether defining core process of the project implementation has a relationship with the project performance. The revealed that majority of the respondents 80.5 % agreed that defining core process of the project implementation has a relationship with the project performance. 19.5 % strongly agreed that defining core process of the project implementation has a relationship with the project performance. Based on this

finding, it can be concluded that defining core process of the project implementation has a relationship with the project performance and it collaborates with literature as stated by (Shantanu Sathe, 2017).

System review and establishment of its reliable and valid measure on project performance

The respondent's views were sought on whether system review and establishment of its reliable and valid measure has a relationship with the project performance. The findings revealed that majority of the respondents 57 % disagreed that system review and establishment of its reliable and valid measure has a relationship with the project performance. 37.3 % agreed that system review and establishment of its reliable and valid measure has a relationship with the project performance and 5.7% strongly disagreed with the statement. Based on this finding, it had been concluded that system review and establishment of its reliable and valid measure don't have a relationship with the project performance and it collaborates with literature as stated (Firat, 2012).

Analysis of findings, gap definition between as-is state and should-be state and the project performance

The respondent's views were sought on analyzing findings, defining the gap between as-is state and should-be state have a relationship with the project performance. The findings revealed that majority of the respondents 89.4 % have agreed that on analyzing findings, defining the gap between as-is state and should-be state have a relationship with the project performance. 1.8 % agreed that on analyzing findings, defining the gap between as-is state and should-be state have a relationship with the project performance and 8.8 % disagreed with the statement. Based on this finding, it had been concluded that on analyzing findings, defining the gap between as-is state and should-be state have a relationship with the project performance and it collaborates with literature as stated (Shantanu Sathe, 2017).

Create new ways to do things; re-engineer the process; validate improvements by simulations and statistical methods; create project plans have a relationship with the project performance

The respondent's views were sought on create new ways to do things; re-engineer the process; validate improvements by simulations and statistical methods; create project plans have a relationship with the project performance. The findings as presented in table 4.24 revealed that majority of the respondents 89.4 % have agreed that on creating new ways to do things; re-engineer the process; validate improvements by simulations and statistical

methods; create project plans have a relationship with the project performance. 4.4 % strongly agreed that create new ways to do things; re-engineer the process; validate improvements by simulations and statistical methods; create project plans have a relationship with the project performance, 5.3 % disagreed with the statement while 0.9 strongly disagreed with the proposed statement that says "create new ways to do things; re-engineer the process; validate improvements by simulations and statistical methods; create project plans have a relationship with the project performance." Based on this finding, it had been concluded that create new ways to do things; re-engineer the process; validate improvements by simulations and statistical methods; create project plans have a relationship with the project performance and it collaborates with literature as stated (Firat, 2012).

Correlations

A correlation is a statistical measure of the relationship among two or more variables. The objective of correctional research is to discover whether variables that have some kind of relationship in one induce some change in the other. Correlation in this study was analysed as this is a correlational research and the results indicated a strong positive correlation factor of 0.774 between road construction project performance and six sigma. This relationship was found to be statistically significant as the significant value was 0.034 which is less than 0.05. This implied that an increase in one factor of six sigma meant that project performance will significantly increase.

FINDINGS

The study sought to establish the relationship between six sigma and performance of road construction project in Rwanda. Under six sigma, its main components were evaluated through respondents rating. Evaluated components in statement forms were: Defining core process of the project implementation has a relationship with the project performance; system review and establishment of its reliable and valid measure has a relationship with the project performance; Analyze findings, define the gap between as-is state and should-be state have a relationship with the project performance; create new ways to do things; re-engineer the process; validate improvements by simulations and statistical methods; create project plans have a relationship with the project performance.

Conclusion

This study sought to investigate the relationship between six sigma as a quality management techniques and the performance of road construction projects in Rwanda. Based on the findings of this study, it was concluded that there is a significant relationship between road construction project performance and six sigma as a technique to improve quality on road project in Rwanda. All components of six sigma which are define the core process, measure the existing system and establish reliable and valid measures, analyze findings, define the gap between as-is state and should-be state, create new ways to do things; re-engineer the process; validate improvements by simulations and statistical methods; create project plans are crucial aspects in relation to road construction projects performance in Rwanda at large. The study also concluded that improving any component of six sigma increased the performance of the partial or overall project performance. The regression coefficients of the study showed that six sigma had a significant positive influence on project performance. This implied that incorporating six in the implementation of road project has a relationship with project performance.

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